

## CLAIMS

We CLAIM:

1           1. A data structure for scheduling one or more event queues, comprising:  
2           a scheduler having a current time and a current epoch bit;  
3           a first event queue having a first event, the first event including a first time stamp,  
4           the first time stamp being associated with a first epoch bit; and  
5           a second event queue having a first event, the first event of the second event  
6           queue including a first time stamp, the first time stamp being associated with a first epoch  
7           bit; wherein the data structure determines a real time by comparing the current epoch bit  
8           with the first epoch bit of the first event queue and the first epoch bit of the second event  
9           queue.

1           2. The data structure of Claim 1, wherein the first time stamp of the first event in  
2           the first event queue compares with the first event in the first time stamp of the first event  
3           in the second event queue if the first epoch bit associated with the first time stamp of the  
4           first event in the first event queue is equal to the first epoch bit associated with the first  
5           time stamp of the first event in the second event queue.

1           3. A method for scheduling one or more event queues and for resolving  
2           timestamp rollover conflicts, comprising:  
3           providing a first bit assigning to a scheduler;  
4           providing a second bit that corresponds to an event queue;

comparing the current epoch to determine timestamp rollover conditions by alternately considering the following comparisons of epoch bits to be true when each time counter rolls over.

4. A data structure for scheduling and arbitration, comprising:

in a root node of a heap tree or similar data structure, comprising:

a first sort index for determining priority of a first event; and

a first data field, concatenated to the first sort index, having a first queue identifier associated with the event; and

in a second level, relative to the root node, of the heap tree or similar data structure, comprising:

a second node with a second sort index for determining priority of a second event and a second data field, concatenated to the second sort index, and having a third node with a third sort index for determining priority of a third event; and a third data field, concatenated to the third sort index, having a third queue identifier associated with the third event.

5. A method for strict priority scheduling in a pile, comprising:

in a first event in a first node, comprising:

providing a first queue having a first sort index and a first data field, the first sort index including a first priority and the first data field including a first event queue identifier;

6 in a second event in a second node, comprising:

7 providing a second queue having a second sort index and a second data

8 field, the second sort index including a first priority and a second data field including a

9 second event queue identifier;

10 determining a priority between the first queue and the second queue based on the

11 first priority in the first queue and the second priority in the second queue; and

12 activating the first queue if the first priority is a higher priority than the second

13 priority and activating the second queue if the second priority is a higher priority than the

14 first priority.

1 6. The method of Claim 5, wherein the value of the first priority in the first sort

2 index is equal to the value of the first event queue identifier in the first data field.

1 7. The method of Claim 5, wherein the value of the second priority in the

2 second sort index is equal to the value of the second event queue identifier in the second

3 data field.

1 8. The method of Claim 5, further comprising removing an event from a root

2 node if the first queue in the first event is not empty by rescheduling the event, and

3 percolating a node corresponding to the event down to a location in a heap-like tree

4 structure.

1 9. The method of Claim 5, further comprising removing an event from a root

2 node if the first queue in the first event is empty by removing the first priority of the first

3 event in the first node; and leaving an empty node in the first node to percolate down a  
4 heap-like structure.

1 10. The method of Claim 5, further comprising inserting an event in the pile by  
2 assigning a designated priority corresponding to a particular queue, and placing the  
3 designated priority and a corresponding identifier in a node.

1 11. A method for ensuring weighted fair queuing in a heap-like tree structure,  
2 comprising:

3 allocating a first service time duration to a first queue having a first event; and  
4 allocating a second service time duration to a second queue having a second  
5 event;

6 if no more events are present in the first queue, comprising:

7 removing the first queue;

8 redistributing the first service time duration;

9 if no more events are present in the second queue, comprising:

10 removing the second queue;

11 redistributing the second service time duration.

1 12. The method of Claim 11, wherein the redistributing of the first service time  
2 duration comprises redistributing remaining event queues proportional to a service rate  
3 associated with the second queue and other queues excluding the first queue.

1 13. The method of Claim 11, wherein the redistributing of the second service  
2 time duration comprises redistributing remaining event queues proportional to a service  
3 rate associated with the first queue and other queues excluding the second queue.

1 14. The method of Claim 11, further comprising removing an event from a root  
2 node if the first queue in the first event is not empty by rescheduling the event, and  
3 percolating a node corresponding to the event down to a location in a heap-like tree  
4 structure.

1 15. The method of Claim 11, further comprising removing an event from a root  
2 node if the first queue in the first event is empty by removing the first priority of the first  
3 event in the first node; and leaving an empty node in the first node to percolate down a  
4 heap-like structure.

1 16. The method of Claim 11, further comprising inserting an event in a pile  
2 including:

3 computing a time required to dispatch an event;

4 placing a queue identifier of the event, and the time to dispatch the event,

5 in a root node of a heap-like tree structure; and

6 percolating the node down in the pile.

1 17. The method of Claim 11, further comprising rescheduling an event queue  
2 including:

3 computing a time required to dispatch a next event in a same queue; and

4 replacing an old timestamp associated with the event with a new  
5 timestamp; and  
6 percolating the node down to a heap-like tree structure.

18. A method for traffic shaping in a pile, comprising:

in a first node, comprising:

a first queue having a first sort index and a first data field, the first sort index having a first priority and a first timestamp, the first timestamp representing a next transmission time for the first queue in the first node, the first data field having a first event queue identifier, the first queue being given a maximum average rate of transmission; and

in a second node, comprising

a second entry having a second sort index and a second data field, the second sort index having a second priority and a second timestamp, the second timestamp representing a next transmission time for the second queue in the second node the second data field having a second event queue identifier, the second queue being given the maximum average rate of transmission.

1 19. A method for scheduling and arbitrating events, comprising:

2 in a root node in a heap-like data structure, comprising:

3 storing an event A in a first event queue having a first priority;

4 in a second level relative to the root node, comprising:

5 storing an event C in a second event queue having a second priority; and  
6 dispatching the event A if the first priority is higher priority than the  
7 second priority, or dispatching the event C if the second priority is high priority than the  
8 first priority .

1 20. The method of Claim 19, further comprising storing an event B after the  
2 event A in the first even queue.

1 21. The method of Claim 19, further comprising storing an event D, an event E,  
2 and an event F in a third event queue.

1 22. A method for inserting an event, comprising:  
2 providing a node having a first event queue identifier and a first timestamp;  
3 and  
4 placing the node at the root node.

1 23. The method of Claim 22, further comprising percolating the node to a  
2 location in a heap-like data structure.

1 24. A method for removing an event, comprising:  
2 providing a root node having an event including a next event queue;  
3 removing the event from the root node, thereby leaving a hole in the root node;  
4 and  
5 percolating the hole to a location in a heap-like data structure.

1 25. A method for rescheduling an event, comprising:  
2 assigning a first timestamp and a first identifier to a first node;  
3 assigning second time stamp and a second identifier to a second node;  
4 rescheduling the first node by assigning a new timestamp in place of the first  
5 timestamp; and  
6 percolating the first node to a location in a heap-like data structure.

1 26. A data structure system, comprising:  
2 a memory queue, for storing a packet to be transmitted onto an Internet link;  
3 a transmission time calculator, for computing a transmission time of the packet;  
4 a queue parameter table for determining the transmission time on the basis of a  
5 specified service rates or hard-coded properties; and  
6 a pile manipulation pipeline, for storing the transmission time and a queue  
7 identifier associated with the packet, and for transmitting the packet when sufficient  
8 transmission time has elapsed in a root node of a heap like data structure.

1 27. A multiple piles in a random access memory (RAM), comprising:  
2 in a RAM having a pile data structure, comprising  
3 a first pile, having a first root node representing a first scheduler;  
4 a second pile, linking to the first pile, having a second root node representing  
5 a second scheduler.

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